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ABSTRACT

The author's stated purpose is to promote greater efforts to prevent the use of so much erroneous material in the schools under the name of science and physics. Two texts are chosen as examples, "Modern Physics" 5th Edition by (Dull) Williams, Metcalfe, Trinklein, and Lefler, and the "Pathways in Science" series by Oxenhorn. Specific errors are cited by page number and the corrections indicated. A request is made for more involvement on the part of physicists in correcting and preventing such errors in textbooks. (TS)

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Several people have asked me for a copy of my talk at the Annual Meeting of the American Association of Physics Teachers, February 1, 1971 in New York.

I have therefore, put the material that was projected on the screen in written form.

School Texts, a Source of Misinformation

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Physicists could increase their impact on science teaching by using their influence to see that inadequate school books are improved or not used. Some college teachers even lend their names and prestige as coauthors without taking any responsibility for what is being written, as will be obvious from some of the examples presented. The book reviewers in our journals have the responsibility to be truthful and warn against books that are full of misinformation. The school teachers cannot be expected to correct the material presented in presumably authoritative books. We can inform the teachers and school administrators about poor books. Editors are often not aware of the ineptness of their writers. Fortunately, students will forget much of the misinformation and no permanent harm may result. Nevertheless, it seems that much of the misinformation is propagated; many books publish the same mistakes, and it is unlikely that they reinvent the same errors. How can students appreciate that science is a rational enterprise, that reasoning pays off, when there is no logical relation possible between incorrect or meaningless statements? Are so many students and teachers afraid of science because the incorrect presentation defies reasoning? (To be published in AJP)

I believe we ought to make greater efforts to prevent the use of so much erroneous material in the schools under the name of science and physics.

Of course, this is not a new problem. The physics community has tried to do something about the teaching in the schools by getting deeply involved in the preparation of new curricula. That does not, however, remove traditional teaching material or other innovative programs which often are not guided by subject matter experts.

SE 012 443

I have chosen primarily two books as examples. One is a very popular high school text in its 5th edition. Modern Physics by (Dull) Williams, Metcalf, Trinklein and Leffer has a college physicist as co-author. There is enough brainpower, manpower, time and money behind such a book to produce a fairly accurate book. I am convinced some of the authors know better, but apparently they allow their names to be used without really taking any responsibility. The few examples that I will discuss are by no means exhaustive, and I am not the only one who finds faults. There are in preparation several quotations from this book by other contributors for the "Would you believe . . .?" column in The Physics Teacher. It is unfortunate that even book reviewers in our AAPT journals praise such a book as "an excellent text," "presenting a rigorous treatment of mechanics," (TPT 7, 295 (1969).

The other examples will be taken from a series of paper back books for slow learners in Junior high schools, Pathways in Science by Oxenhorn. The first book of this series, which is no better or worse than the others, was unfortunately described in a recent book review in The Physics Teacher as "The correct terms are used and the physics seems to be accurate." (TPT 8, 411 (1970). The few examples that will be discussed represent a very small fraction of the wrong and misleading statements in these books. These books present an excellent source of ideas for wrong choices for multiple choice questions.

I have invited some of the authors and publishers of these books and hope they are present to defend their books, explain why such errors seem unavoidable, and tell us how physicists can help.

Apparently one of the problems is that the publishers are not even aware of the shortcomings. They frequently have their own experts and consultants in whom they believe, and they resent the opinions of others. One publisher seemed surprised

when some of the errors were called to his attention and wrote "Perhaps we should have had the manuscript read by physicists as well," and not only by specialists in science education.

The users and the book selectors in the school systems apparently are not aware of the many errors either, or they have found that more correct books have other even more undesirable features. Therefore, it is up to the physicists to make every effort to have these books revised or removed.

One can hope that the children will forget the nonsense they have learned in grade school, although I suspect that the symposium on Elementary Education at this meeting will probably emphasize that that is the age where concepts and attitudes are being established.

At the high school level it is probably also true that much will be forgotten. There seems to be some evidence, however, that the misconceptions college students have are the same as the ones which these books promote. It is difficult to believe that each generation of students develops these misconceptions independently.

Physics is a rational subject. How can we expect the students to think if the source material presents such illogical and incomprehensible, inconsistent material.

We often cite as one of the problems of physics teaching the inadequate training of many teachers who teach high school physics. Why then give them such impossible material? It is no wonder that teachers and students become discouraged with physics. Under the circumstances they have to resort to memorizing what is presented as facts because the logical relations are obscurred by the presentation. We cannot expect to have a scientifically literate population if our children are brought up on such nonsense. One should not encourage the students in their attitude that words don't mean anything anyway.

As you will see, in addition to many careless mistakes which a careful reader might be able to correct, there are many real misconceptions and poor logic.

I have concentrated in this presentation on items that occur in diagrams and short paragraphs but many more involved sections of misrepresentations can be found.

Examples.

"The path taken by an independent N pole in a magnetic field is called a line of flux" (M-473*). This ignores the fact that an object already in motion will, due to its momentum, in general not follow a path given by the direction of the force.

A similar error is made in describing the frictional force as "opposite to the force producing . . . motion."(M-53) Sliding friction is opposite to the velocity no matter what other forces are acting.

Careless instruction to the draftsman and poor proofreading account for describing the electromagnet in a mass spectrograph as a charged coil(M-585) (to match the description of the charged deflection plates).

The conservation law of momentum is stated as: "The total momentum of the system is zero" instead of constant, without any reference to the center of mass system (M-666).

Similarily the conservation law of leptons is stated that "the arithmetic sum of the lepton number is zero on each side of the equation" (M-666) which should be stated as "the same."

In discussing the efficiency of a Carnot engine the authors confuse the heat supplied during an isothermal expansion with the internal energy at that temperature and use this as an argument to set the heat proportional to the temperature (M-214).

In discussing the relativistic limitation of a cyclotron, it is stated "This increased mass slows down the particles," confusing a smaller acceleration with a deceleration - a decrease

* References are to page number. M: Modern Physics by J.E. Williams, H.C. Metcalfe; F.E. Trinklein, R.W. Lefler (C.Dull). Holt, Rinehart and Winston, Inc. 1968.

of speed. (M-589) (Possibly they mean decrease of angular velocity, but that should be expressed more clearly.)

Quantities of different nature are compared in stating that "the force of gravitational attraction (on a large drop of mercury on a flat surface) is greater than the surface tension" (M-191).

A water surface in a capillary is shown in an unintelligible way. (M-191).

The action of a magnifying glass is illustrated with what appears to be a partial ray diagram, showing the image on the wrong side of the lens (P-3-136)**.

A convex lens is shown to make a parallel beam of light diverging, but it still corrects for the farsighted eye (P-3-134).

A diagram to show "how images are formed" by means of mirrors shows lines that might be light rays, but they show no change in direction at the mirror although they are obviously not normal to the mirror surface (P-3-120).

The center of mass of a truck is shown repeatedly at the top of the load in the truck no matter how much the truck is loaded (P-2-66).

A diagram of a loudspeaker shows the paper cone filled with carbon grains (to match the microphone?) (P-3-70).

The socket for a light bulb is shown in a way so as to cause a short circuit, and a choke is inserted in a light circuit for no apparent reason (P-3-157).

In describing that a heavier weight lifts a smaller weight by means of a string passing over a pulley fastened to the ceiling, the transfer of potential energy from one to the other is attributed to kinetic energy (P-2-34).

** References to volume and page number

P: Pathways in Science by J. M. Oxenhorn (etal.) Globe Book Co. 1968-1970.

Peculiar qualifications are introduced in the conservation law of energy by stating that "Energy can neither be created nor destroyed by everyday means" and that "the total amount of the world's energy remains almost the same." (P-2-39)

The distinction of potential energy and kinetic energy seems to take the form that one is "waiting" and the other "does the real work." (P-2-30), and one wonders how a flywheel might enter the discussion.

There are cases of inconsistent current directions (P-1-93) and wrong directions of the magnetic field around currents (P-1-92) and inconsistent use of the marking of magnet needles in compasses (black - north?) (P-1-76). Three dimensional magnets have only two dimensional fields (P-1-76).

It is claimed that the pole near the geographic north pole is a magnetic north pole (P-1-80).

In an experiment to explain the effect of using two dry cells instead of one on the strength of an electromagnet, the length of the magnet and the number of turns are changed simultaneously, and the magnet is shown as having its greatest strength at the center (P-1-94).

We are expecting too much if we leave it to the teachers to recognize and correct the errors. I know that I frequently do not take the time because it interrupts the discussion and seems to put the emphasis on peripheral topics. In addition, at the lower grades we cannot expect the teacher, who has to be an expert in so many areas, to be sufficiently familiar with the subject matter to contradict the textbook authorities.

Since consumer legislation has not advanced to the stage where one could sue authors and publishers or school system using such books, for malpractice, it is up to us to tell teachers and science supervisors that we do not approve of the

use of such books and to publicise whenever possible the shortcomings of these texts. Maybe we can offer our services as consultants to publishers and take the responsibility seriously. I would like to invite you to contribute to the "Would you believe . . .?" column by sending in, with or without comments, error quotations from textbooks.

Discussion

It was pointed out that the physics discussed in Earth Science texts is even more erroneous than what is found in physics texts.

One of the coauthors of Modern Physics expressed his appreciation for having errors pointed out before the new edition goes into print.